Do maize above- and belowground residues differ in their in situ degradability? A year-round field study of ^{13}C natural abundance resolved CO_2 emissions

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Introduction

Various carbon (C) sources affect differently the soil organic carbon (SOC) dynamics due to the chemical characteristics and the interaction with soil. Field studies suggested aboveground biomass less efficient than belowground biomass in contributing to built-up and long-term preservation of SOC (Rasse et al., 2005), but it was not the case for lab-based incubations. The question then emerges as to whether this contradiction is due to the absence of a comparable physical disturbance as introduced in any incubation.

Objectives

In this study, a shoot and root exclusion approach and natural-^{13}C labeling technique are applied to confirm and time the differential degradation of maize (*zea mays*) shoots and roots under field conditions.

Materials and methods

A field trial with five treatments was run in Melle, Belgium on a light-sandy loam textured soil (**Table)**: maize field where roots were removed as T_0, where roots were chopped and incorporated back to the soil as T_{mr}, and where roots stayed in situ as T_{ris}; C_3 crop field with maize root (T_{C3r}) and shoot (T_{C3s}) incorporation. Soil respiration was estimated based on a LI-8100 automated soil CO_2 flux system and chamber-based trace gas flux measurements.

Results

Figure shows the primarily results that T_{C3s} displayed a higher CO_2 flux than the other treatments. No significant extra CO_2 emission from rhizodeposition C inputs on soil respiration could be indirectly inferred by comparing bulk CO_2 emissions from the previous maize field without (T_{mr}) and with (T_0) removal of roots after harvest The Keeling plot approach was used to estimate $\delta^{13}C$ value of soil respiration and the fraction of maize-derived CO_2 was further calculated. Monthly decomposed maize-derived C was calculated from the maize fraction in soil respiration and the average soil CO_2 flux.

Conclusion

After incorporation, aboveground biomass is biologically less stable than belowground biomass in soil during winter and thus should contribute less to stabilized SOC. Currently, soil CO_2 flux measurements are still on-going thus more information of seasonal changes in soil respiration and its $\delta^{13}C$ value will be presented at the SOM 2017 conference.

Reference

Rasse, D.P., Rumpel, C., Dignac, M.-F., 2005. Is soil carbon mostly root carbon? Mechanisms for a specific stabilisation. Plant Soil 269, 341–356.

Table: Soil characteristics of different treatments

Treatment	Plot	Initial SOC [g/kg]	δ¹³C [‰]	Additional maize-C input [kg/m²]
	1	8.1	-23.84	-
T_{m0}	2	8.2	-24.23	-
	3	12.1	-25.07	-
	1	8.1	-23.84	0.03R
T_{ris}	2	8.2	-24.23	0.05R
	3	12.1	-25.07	0.03R
	1	8.1	-23.84	0.03R
T_{mr}	2	8.2	-24.23	0.05R
	3	12.1	-25.07	0.03R
	1	12.1	-26.87	0.03R
T_{C3r}	2	8.7	-25.58	0.05R
	3	9.5	-26.30	0.03R
	1	12.1	-26.87	0.40S
T_{C3s}	2	8.7	-25.58	0.51S
	3	9.5	-26.30	0.59S

R: root; S: shoot.